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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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MUETING, RAASCH & GEBHARDT, P.A.
P.O. BOX 581415
MINNEAPOLIS, MN 55458

EXAMINER

JOHNSTON, PHILLIP A

ART UNIT	PAPER NUMBER
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2881

DATE MAILED: 01/15/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/003,224

Applicant(s)

LARSON ET AL.

Examiner

Phillip A Johnston

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☐ Responsive to communication(s) filed on ____.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-50 is/are pending in the application.
- 4a) Of the above claim(s) ____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) ____ is/are allowed.
- 6) ☒ Claim(s) 1-50 is/are rejected.
- 7) ☒ Claim(s) 10 is/are objected to.
- 8) ☐ Claim(s) ____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 28 July 2002 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on ____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. ____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 6
- 4) ☐ Interview Summary (PTO-413) Paper No(s) ____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: ____

Detailed Action

Claims Objection

1. Claim 10 is objected to because of the following informalities: Page 38, Claim 10, "The method of claim 10" should be "The method of claim 9". Appropriate correction is required.

Claims Rejection – 35 U.S.C. 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which the subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

3. Claims 1-50 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 6,447,891 to Veerasamy, in view of Miyawaki U.S. Patent No. 5,543,648.

Regarding Claims 1-5, 22 and 35, Veerasamy (891) discloses a method for XPS analysis of thin film samples approximately 750 Å⁰ thick, wherein, high energy x-ray photons (monochromatic) impinge on the surface of layer 9. Electrons from the surface are ejected and their energy and number (count) measured. With these

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measurements, one can deduce the electron binding energy. From the binding energy, one can determine three things: elemental fingerprinting, relative quantity of elements, and the chemical state of the elements (i.e. how they are bonding).

Components used in the XPS analysis include the monochromatic x-ray source, an electron energy analyzer, and electron flood gun to prevent samples from charging up, and an ion source used to clean and depth profile. Photoelectrons are collected from the entire XPS field simultaneously, and using a combination of lenses before and after the energy analyzer are energy filtered and brought to a channel plate. The result is parallel imaging in real time images. See Column 18, line 64-67, and Column 19, line 1-14.

In addition Veerasamy (891) teaches that the ion beam source functions to deposit a DLC inclusive layer 9 on substrate 1 over layers 2-7 so as to be in contact with layer 7 (e.g., layer 7 may be of silicon nitride to improve bonding between layers 7 and 9). See Column 16, line 5-8.

It is implied herein that a computing apparatus, as recited in Claims 46-50 was utilized to perform the XPS analysis and produce the real time images in accordance with Veerasamy (891) above.

Regarding Claims 11,15,19,20,26 and 34, Veerasamy (891) discloses in FIG. 8 the % concentration, with regard to C, O and Si for layers 9 and 10, while FIG. 9 shows the % concentration, with regard to C, O and Si for layer 11, throughout the respective thicknesses of these layers. X-ray Photoelectron Spectroscopy

(XPS)/Electron Spectroscopy for Chemical Analysis (ESCA) was used to develop these graphs from sample products. See Column 20, line 10-16.

Although Veerasamy (891), did not disclose the measurement of % concentration of Nitrogen, as recited in Claims 11,15,19,20,26 and 34; however, since similar elements such as Carbon and Oxygen were measured, it would have been obvious to one of ordinary skill in the art that the measurement of % concentration of Nitrogen could have been included in the XPS analysis in accordance with Veerasamy (891), if so desired.

Regarding Claims 6-8, 29-31 and 36-38, Veerasamy (891) also teaches that Information on the surface is obtained from a lateral dimension as large as 1 mm diameter and from a depth of 0-10 .mu.m. To acquire information from slightly greater depths, angle resolved measurements can be made. See Column 20, line 30-33.

Regarding Claims 9,10,32,33,39-41,44 and 45, Veerasamy (891) as applied above disclosed an ion source to depth profile, wherein elemental concentration was measured as a function of material removal from the surface; i.e. sputter time vs. depth, as shown in Figures 8 and 9. Veerasamy (891) further discloses FIG. 8 illustrates the % concentration of C, O and Si throughout the thicknesses of DLC inclusive layers 9 and 10 of protective coating system 15 of the FIG. 2(a) embodiment. Cycle number 1 is at the outer surface of layer 10, while cycle number 19 is believed to be within the underlying glass substrate 1 (remember, layers 9-10 were deposited directly on a glass substrate absent layers 2-7 for purposes of this test). Thus, it is



believed that the interface between glass substrate 1 and underlying DLC inclusive layer 9 is at about cycle number 15 where the C % begins to significantly decrease. The "time" and "depth" columns refers to depth into layers 10, 9 from the exterior surface of layer 10 as compared to the depth into a conventional SiO₂ that would be achieved over the same time period. Thus, the angstrom depth illustrated in FIG. 8 is not the actual depth into layers 10, 9, but instead is how deep into a SiO₂ layer the sputtering would reach over the corresponding time. See Column 20, line 34-52.

Veerasamy (891) further teaches that, the optimal ion energy window for the majority of layers 9, 10 is from about 100-1,000 eV, (preferably from about 100-400 eV) per carbon ion. At these energies, the carbon in the resulting layers 9 and/or 10 emulates diamond. However, compressive stresses can develop in ta-C when being deposited at 100-150 eV. Such stress can reach as high as 10 GPa and can potentially cause delamination from many substrates. It has been found that these stresses can be controlled and decreased by using an ion energy during the deposition process in a range of from about 200-1,000 eV. Also, at particle energies (carbon energies) of several hundred eV, a considerable material transport can take place over several atomic distances. This is caused by the penetration of fast ions and neutrals as well as by the recoil displacement of struck atoms. At sufficiently high particle energies and impact rates, there is an enhanced diffusion of the thermally agitated atoms near the film surface that occurs via the continuously produced vacancies. See Column 16, line 39-61.

Although Veerasamy (891) does not disclose the use of a <500ev ion energy beam for depth profiling, as recited in Claims 9,10,32,33,39-41,44 and 45, it would have been obvious to one of ordinary skill in the art that Veerasamys'(891) use of <500 ev ion beams for coating deposition, could also be used to optimize material removal in XPS depth profiling, if so desired.

Regarding Claims 17,21,and 28, Veerasamy (891) disclosed an Ion beam source 25, which includes gas/power inlet 26, anode 27, grounded cathode magnet portion 28, magnet poles 29, and insulators 30. A 3 kV DC power supply may be used for source 25 in some embodiments. Linear source ion deposition allows for substantially uniform deposition of layers 9 and 10 as to thickness and stoichiometry. The ion beam emanating from the slit is approximately uniform in the longitudinal direction and has a Gaussian profile in the transverse direction. See Column 14, line 24-29, and Column 15, line 5-7.

4. Claims 12-14,16,18,23-25,27,42 and 43, are rejected under 35 U.S.C. 103(a) as being unpatentable over Veerasamy (891), as applied above to Claims 1-11,15,17,19-22,28-41, and 44-50, in view of Miyawaki (648).

Miyawaki (648) discloses a Semiconductor device with nitrided silicon dioxide films , wherein to attain a degree of integration of 256M bit to 1 G bit level in DRAM, it is necessary that an insulating layer formed on the surface of a semiconductor has a very small thickness such as 1.0 to 1.5 nm. Column 1, line 36-40. In addition, the

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degree of hydrogenation-treated state on the surface of substrate (S) was evaluated by determining the thickness of the spontaneously oxidized film formed on the surface by an XPS (X-ray Photoelectron Spectroscopy) apparatus. See Column 5, line 1-5.

Miyawaki (648) also disclosed an integrated circuit device of 200,000 gates of MOS-FETs, which was prepared with monocrystalline Si thin film. The gate oxide films of MOS-FETs were formed to a thickness of 100 Å⁰ by dry oxidation at 1,000.degree. C. The dielectric strength of the thus formed oxide film was such a high value as 12 MV/cm or higher at all the MOS-FETs. See Column 6, line 23-49. The wafer processed up to the step as shown in FIG. 3B was dipped in a mixture of platinum-hydrogen peroxide solution, whereby a thin oxide film having a thickness of ten Å⁰ on the wafer surface was formed. Then, the wafer was heated in an N₂ atmosphere at 500 degree C to increase the density of the thin oxide film. By this treatment, an oxide film 17 having a very uniform thickness and a good quality could be formed at such a low temperature as 500 degree C. See Column 10, line 10-18.

Miyawaki (648) further teaches in FIG. 6, that numeral 18 is BPSG (boron-phosphorus doped glass), and 19 is an SiO₂N_{1-x} film. By providing a layer composed of a material having distinguished reflow characteristics at the bonding interface, as compared with SiO₂, the bonding became more complete and the uniformity was improved. In this example, a combination of BPSG with the SiON film has been explained, but NSG (non-doped glass) or PSG having better reflow characteristics than those of BPSG or thermally oxidized SiO₂ film, which is formed by CVD can be

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provided alone, and besides SiON, it is possible to use AlN, SiN, or their combinations.

See Column 10, line 29-45.


Therefore, it would have been obvious to one of ordinary skill in the art that the Veerasamy (891) method and apparatus for thin film characterization can be modified for use with Miyawaki's (648) gate dielectric film process, to further extend the utilization of XPS depth profiling to the nitrided silicon dioxide films used in semiconductor manufacturing processes.

Conclusion

5. Any inquiry concerning this communication or earlier communications should be directed to Phillip Johnston whose telephone number is (703) 305-7022. The examiner can normally be reached on Monday-Friday from 7:30 am to 4:00 pm. If attempts to reach the examiner by telephone are unsuccessful, the examiners supervisor John Lee can be reached at (703) 308-4116. The fax phone numbers are (703) 872-9318 for regular response activity, and (703) 872-9319 for after-final responses. In addition the customer service fax number is (703) 872- 9317.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703 308 0956.

PJ
January 6, 2003


JOHN R. LEE
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2800